Site Survey of the Mine Burial/Coastal Processes Experiment Site at the WHOI Coastal Observatory, Martha's Vineyard

John A. Goff
University of Texas Institute for Geophysics
4412 Spicewood Springs Rd., Bldg. 600, Austin, TX 78759
phone: (512) 471-0476; fax: (512) 471-0999; email: goff@ig.utexas.edu

Award Number: N00014-02-1-0206
http://www.ig.utexas.edu/research/projects/mine_burial/CH02-15_report.htm

LONG-TERM GOALS

The primary goal of the ONR Mine Burial Prediction Program is to provide to the Navy quantitative estimates of the likelihood of mine burial following deployment. To do this, it is essential to have an accurate assessment of the geologic and oceanographic conditions and understanding of the sedimentary processes acting in proximity to the mines.

OBJECTIVES

The ONR Mine Burial working group, which met in St. Petersburg at the end of January, 2001, identified Woods Hole Oceanographic Institution's coastal observatory off the coast of Martha's Vineyard (Figure 1) as one of two primary test sites. Our primary objective was to conduct a thorough site survey of this region – including swath mapping, geotechnical measurements, sampling, coring and seismic reflection. Our expectation is not only to establish the basic geological conditions at the mine burial test site, but also to put the test site in a more regional geologic context of a basic understanding of the processes acting in this near shore environment. The site survey is intended as a baseline against which changes in the seabed can be measured.

APPROACH

The site survey of the Martha's Vineyard Coastal Observatory (MVCO) was a collaborative effort among a number of PI's within the ONR Mine Burial Prediction Program. John Goff (UTIG) acted as site survey coordinator, and chief scientist for the work aboard the *R/V Cape Henlopen*. Goff was also to conduct grain size analysis of grab samples collected. Larry Mayer (UNH), a co-PI on this proposal, planned and oversaw high resolution swath mapping using the Reson 8125 focused multibeam system. The UNH group also collected velocity and resistivity measurements with the ISSAP (*In-situ* Sound Speed and Attenuation Probe) instrument. Grab samples and geotechnical measurements were collocated so that grain size distribution could be compared with velocity and porosity. Bill Schwab (USGS-Woods Hole) conducted a backscatter and bathymetry survey using a Submetrix system. Roy Wilkins (U. Hawaii) coordinated use of the vibracore system, and oversaw grain size analysis from the cores in collaboration with Ilya Buyenevich (WHOI). Rob Evans (WHOI) and Steve Schock (FAU) conducted a chirp seismic reflection survey. Goff performed stratigraphic analysis of the chirp data. Peter Traykovski (WHOI) has also been collecting sediment samples and pole-mounted sector scanning sidescan data to image bedforms. He also directed diver-deployed push cores at the edges of grain-size boundaries, which were analyzed by Goff for grain size distribution.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **30 SEP 2004**	2. REPORT TYPE	3. DATES COVERED **00-00-2004 to 00-00-2004**

4. TITLE AND SUBTITLE **Site Survey of the Mine Burial/Coastal Processes Experiment Site at the WHOI Coastal Observatory, Martha's Vineyard**	5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **University of Texas Institute for Geophysics,,4412 Spicewood Springs Rd., Bldg. 600,,Austin,,TX,78759**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**6**	

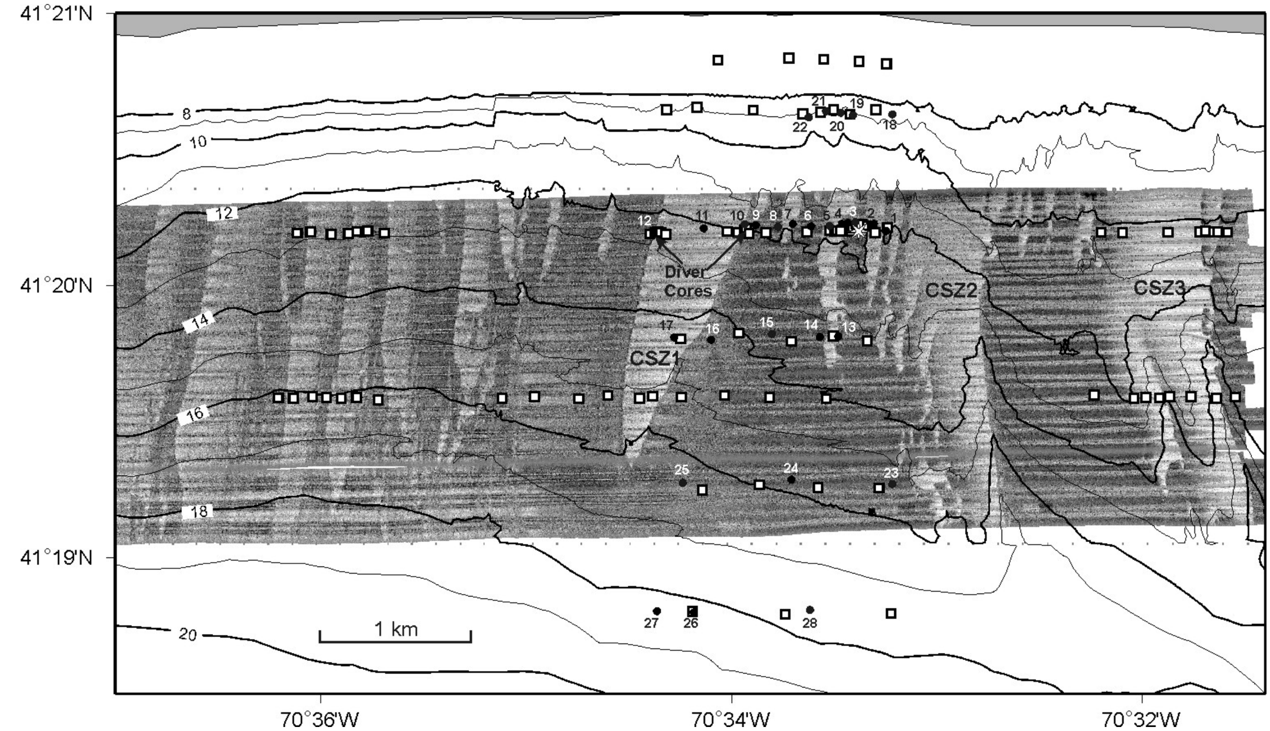

Figure 1. Backscatter survey maps from September 2001 Submetrix 234 kHz swath survey. Higher backscatter is indicated by lighter shades. Bathymetric contours, in meters, are derived from merged NGDC and Reson 8125 data. Squares indicate grab sample stations and numbered, filled circles indicated vibracore sites and their station numbers. The larger coarse sand zones, seen as high backscatter areas, are identified as CSZs1-3. Star indicates location of the MVCO node.

WORK COMPLETED

The previous year has seen a synthesis of the data collected in 2001 and 2003 into an overview paper of the geological and geophysical site survey of the MVCO (Goff et al., in press).

RESULTS

We have examined in detail the seafloor and cross-sectional morphology of sorted bedforms (i.e., "rippled scour depressions"; e.g., Cacchione et al., 1984; Theiler et al., 1995; Schwab et al, 1997)) in the Martha's Vineyard Coastal Observatory (MVCO). Sorted bedforms are seen as alternating bands of coarse and fine sands oriented nearly perpendicular to the shoreline. The coarse sand zones (CSZs) of the sorted bedforms are tens to hundreds of meters wide, and extend up to several kilometers from the shoreface. Data considered here include time series of swath backscatter and bathymetry, high resolution chirp seismic reflection, and grain-size analyses from grab samples, vibracores and push cores. The sorted bedforms observed within the MVCO survey area exhibit a broad spectrum of bathymetric relief (from ~10 cm to ~ 3 m), grain size contrast (from ~250 μ to > 2000 μ) and morphologic form (moats, steps, and dune forms). All forms observed display lateral asymmetry in both grain size and bathymetric expression. In general, grain size is largest and bathymetry is deepest toward one side, typically seen in the backscatter maps as the more well defined of the two CSZ edges where that distinction can be made. These observations are consistent with earlier studies suggesting that sorted bedforms are a response to a transverse, alongshore flow. Within the MVCO survey area, the sense of asymmetry changes polarity going from west/shallow water to east/deeper water, suggesting a complex hydrographic regime.

Our time series data demonstrate variability in the location of the boundaries between coarse and fine sands, with movements of tens of meters over spans of months (Fig. 2), but great stability in the bathymetric features, with little or no migration seen over the same time span (Fig. 3) and little detectable movement observed for larger features over a span of nearly four decades. Furthermore, the direction of migration of the coarse/fine sand boundaries is often at odds with expectations based on the asymmetries of the sorted bedforms, and push-core results indicate movement both of fine sands over coarse and vice versa (Fig. 4). We speculate that sorted bedform migration may, in the short term, be controlled by small-scale ripple migration forced by wave orbital velocity skewness, and in the long term by alongshore currents.

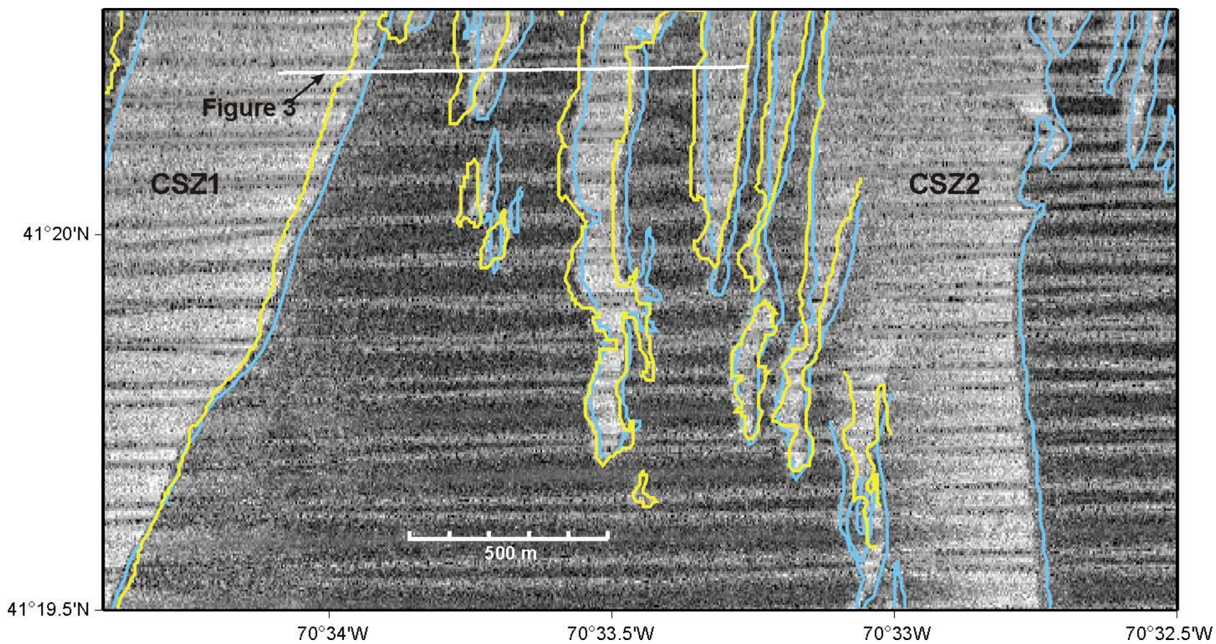

Fig. 2. September 2001 Submetrix backscatter data in the central sector of the survey, with digitized coarse/fine sand boundaries from the February 2001 DF1000 survey (yellow) and July 2002 Reson 8125 survey (light blue) overlain. The location of the profile used for Fig. 3 is shown. Higher backscatter is indicated by lighter shades. [Sorted bedform boundaries have shifted by 10's of meters over time spans of months]

Beneath the sorted bedforms lies a shallow, horizontal seismic reflector, a few tens of centimeters below the seafloor in the shallower waters, and > 1 m in deeper water. This reflector is consistently present below the fine sands and is often observed, although less defined, beneath the coarse sands. It is often continuous beneath transitions between fine and coarse sands at the surface. In sediment cores, this reflector appears to correlate to a variable-thickness layer of gravel/very coarse sands that is frequently present beneath both coarse and fine surface sands. This surface also caps a buried fluvial channel system. We interpret this horizon as an erosional lag delineating a transgressive ravinement surface and the contact between poorly sorted glacio-fluvial sediments below and reworked, well- to moderately-well-sorted fine and coarse sands above.

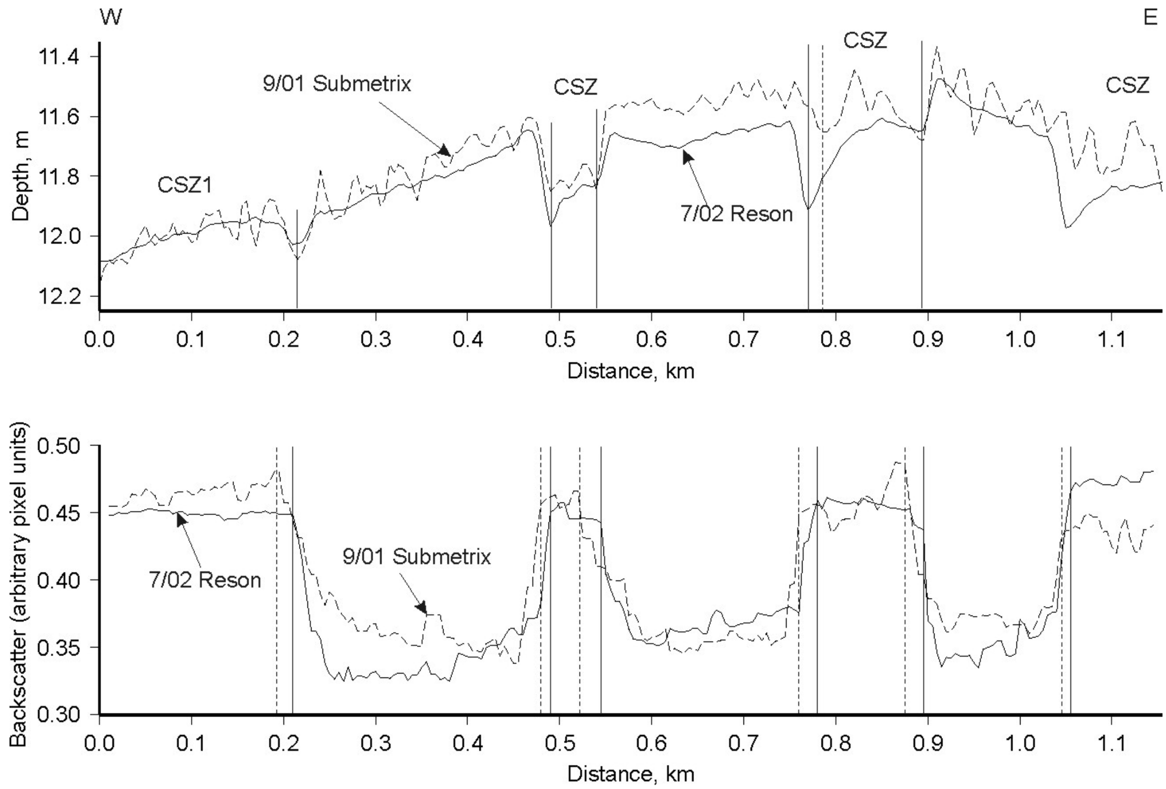

Fig. 3. July 2002 Reson 8125 (solid) and September 2001 Submetrix (dashed) bathymetry (top) and backscatter (bottom) profiles (see Fig. 2 for location). Vertical lines (solid for Reson, dashed for Submetrix surveys) mark locations of identifiable features, moats for the bathymetry and the shoulders of backscatter highs in the backscatter data, that are used to established temporal shifts between the two surveys. [The backscatter features consistently indicate a ~10-20 m shift to the east between the earlier Submetrix and later Reson surveys. In contrast, most of the bathymetric features show no shift.]

IMPACT/APPLICATIONS

Our site survey and time series observations should lead to a substantial advancement in the understanding of the dynamics of the MVCO in particular, and RSDs in general.

RELATED PROJECTS

None that I am aware of.

REFERENCES

Cacchione, D.C., Drake, D.E., Grant, W.D., and Tate, G.B., 1994, Rippled scour depressions on the inner continental shelf off central California, Journal of Sedimentary Petrology, v. 54, p. 1280-1291.

Schwab, W.C., Allison, M.A., Corso, W., Lotto, L.L., Butman, B., Buchholtz ten Brink, M., Denny, J.F., Danforth, W.W., and Foster, D.S., 1997, Initial results of high-resolution sea-floor mapping offshore of the New York-New Jersey metropolitan area using sidescan sonar, Northeastern Geology and Environmental Sciences, v. 19, p. 243-262.

Thieler, E. Robert , Brill, Andrew L. , Cleary, William J. , Hobbs, Carl H., III , Gammisch, Ro - Geology of the Wrightsville Beach, North Carolina shoreface; implications for the concept of shoreface profile of equilibrium, Marine Geology, v. 126, p. 271-287.

PUBLICATIONS

Goff, J. A., Mayer, L. A., Traykovski, P., Buynevich, I., Wilkens, R, Raymond, R., Glang, G., Evans, R. L., Olson, H., Jenkins, D., in press. Detailed investigation of sorted bedforms, or "rippled scour depressions," within the Martha's Vineyard Coastal Observatory, Massachusetts. *Cont. Shelf Res*. [in press, refereed]

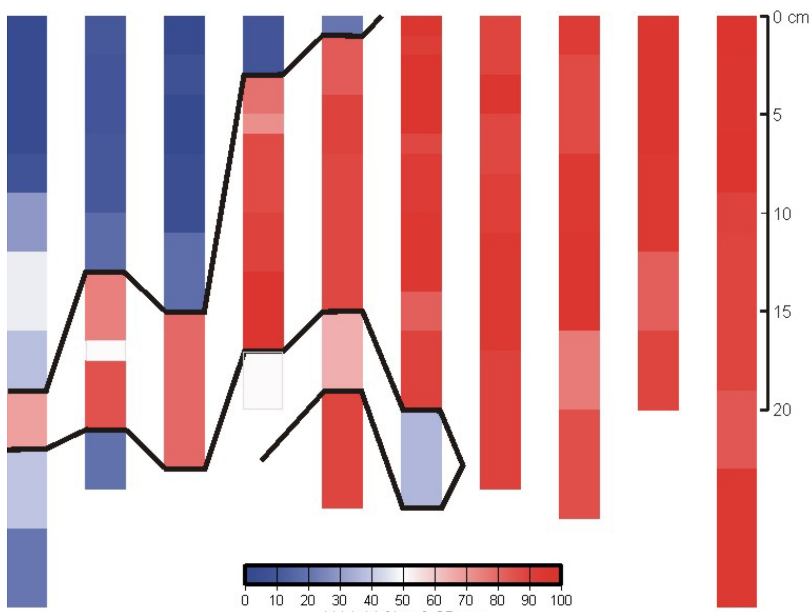

Fig. 4. Results of grain size analysis on diver cores gathered at the western edge of CSZ1 (Fig. 1). Cores are located at 1 m intervals crossing the transition between fine and coarse sands. After splitting, between 5 and 10 subsamples were selected from each core for analysis, guided by visual identification of grain size boundaries. Observations of bimodality in the distribution lead us to characterize the coarse versus fine sand content of each sample by measuring the total weight percentage greater than 0.25 mm, a value which clearly separated the two peaks of the distribution. Heavy lines indicate interpreted contiguous grain size boundaries. [The microstratigraphy sampled in these cores indicates movement both of fine sand over coarse and vice versa]